DOCUMENT RESUME

ED 362 400 SE 053 673

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TITLE Girls and Science Careers: Positive Attitudes Are Not Enough.
PUB DATE 92
NOTE 28p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (Boston, MA, March 1992).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Career Choice; *Career Education; Classroom Research; *Cooperative Learning; Elementary School Science; Elementary School Students; Elementary Secondary Education; Females; Role Models; *Science Careers; *Science Education; Secondary School Science; Secondary School Students; *Sex Differences; Student Attitudes; *Student Centered Curriculum; Teaching Methods

ABSTRACT

The question of why so few women enter scientific fields of study is important to American society. This paper examines two questions concerning the career aspirations of students: (1) What attitudes do students have about science and careers in science? and (2) How do variables such as classroom structure, grade level, gender, peer influence, parents, and role models affect these attitudes? A classroom structure method assessment was given to 40 classes, 10 from each of the following grades: 2, 5, 8, and 11. From these classes, two distinct types of classroom structures at each grade level (16 classrooms) were selected and these students were given a measure of Individual Versus Group Attitudes Towards Science (n=408). Approximately 10 students from each group were interviewed and given open-ended sentence completion tests. Two types of classroom structures emerged: cooperative student-centered and competitive teacher-centered. Students who expressed interest in science careers in the interviews could name specific adult role models who sparked an interest in science for them. Student attitude towards science decreased with increasing grade. One of the most serious implications from the data is that so many students are relatively unclear about career options in science. Early career development may be especially critical for females, who frequently correlated taking future math and science courses only with a decision to pursue a career in science. (PR)

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Girls and Science Careers: Positive Attitudes are Not Enough

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SE 053 673

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Girls and Science Careers: Positive Attitudes are not Enough

Introduction

Research documents a decline of student attitudes towards science. It also indicates that student attitudes in science might be influenced by variables such as (1) classroom structure, (2) parents, role models, peers and/or social factors, (3) gender, (4) and grade level.

This decline in attitude is correlated with a decline in student enrollment in math and science courses in high school and college, and with a decline of students choosing to enter scientific fields of study. According to Tominson-Keasey, Halpern and Jundsford (1991), only 7% of today's high school students are choosing science and math as majors when they start college. And few of these students are likely to be female Hill, Pettus & Hedin, (1990). The National Science Foundation (1986) reports that only 13% or employed scientists and engineers are women.

Considering our country's gradual decline in the ability to compete in the world's technological marketplace, and our country's gradual increase in the number of women in the workplace, the question of why so few American students, and why so few women specifically, enter scientific fields of study is crucially important to our society today.

This paper shall examine career aspirations students: (1) What attitudes do students have about science and careers in science and (2). How variables such as classroom structure, grade level, gender, peer influence, parents and role models affect these attitudes? The Wall Street

Journal (1988) reports that 66% of all jobs have been eliminated when students drop enrollment in science and math classes. Acknowledging that all citizens have the right to realize their full potential and contribute to building our community includes equal access to science classes and careers. This study shall also attempt to bridge research to classroom practices, with practical significance for science teachers.

Background

Poor student attitude has been given as an explanation for low enrollment in science courses and marginal interest in scientific careers. The 1976-77, 1981-82, and 1985-86 National Assessments of Educational Progress documented a decline, from earlier to later grades, in attitude toward science (Ward, 1979; Hueftle, Rakow & Welch, 1983; Mullis & Jenkins, 1988). Although there have also been decreases in attitude toward science since 1977, it is not as large as the continuing differences across the grade levels.

Previous gender differences research have reported boys to have better attitudes toward science than do girls. However, several meta-analyses have lead to conflicting conclusions. Steinkamp & Maehr (1983) concluded that girls do not like science less than boys and in some cases such as biology and chemistry, they like science more than the boys. Conversely, Fleming & Malone (1983), in their meta-analysis, concluded that, except for the junior high years, girls liked science less than boys.

Other variables, in addition to grade level and gender, have been suggested as an explanation for contributing to decreased student attitudes and enrollment rates in science courses. Maple and Stage (1991) found

that parental influence, attitudes, locus of control, number of math and science courses taken and future course taking plans examined together in a regression analysis accounted for only 10.9% of the variance in the selection of college majors for white females.

Socialization, and in particular the lack of live or text-book role models, (Jones & Wheatley, 1988: Tomlinson-Keasey, Halpern & Lundsford, 1991) has been suggested as a reason why so few females choose science. This hypothesis is supported by Hill, Pettus and Hedin (1990) who found that science related career decisions for black and white males and females was strongly related to personal contact with a scientist. Boli, Allen and Payne (1985) found that a female mathematics teacher in high school was related to better performance and persistence in college mathematics and science courses for high ability females.

Research suggests that major variables in classroom structure (cooperative or competitive, student-centered or teacher centered), are powerful in determining the attitudes of students in general, and will operate differently for girls and boys. Okebukola (1986) found that using cooperative methods of instruction with secondary science students in a laboratory setting was a potent way of assisting students in developing favorable attitudes towards laboratory work. In particular, he found that females in a cooperative lab setting had a positive attitude toward lab work. Foster (1985) found that fifth and sixth grade students of both genders were more self-motivated in a cooperative learning setting. In science, Lazorowitz (1988) also found that using small, cooperative investigative groups in secondary biology class resulted in higher pupil on-task behavior, which is considered a sign of pupil satisfaction.

The degree to which the classroom is teacher centered or student centered has an influence on attitude toward science. Results from the National Assessment of Educational Progress (Mullis and Jenkins, 1988) suggested that two climate variables might be particularly important. These were the degree of competitiveness and the locus of control between students and teacher. It appeared that girls would prefer more student centered and cooperative classrooms, and boys more competitive and teacher centered classrooms.

Sample

This investigation was conducted in a suburban school district composed of 2050 students. The community is predominately white, middle and upper middle class residents with less than 10% minorities overall. Individual schools varied in minority population. Two of the schools in which the research was done documented a minority population of 33%. The unified school system contains 5 high schools, 5 middle schools and 15 elementary schools.

A search in 40 of this district's classrooms, 10 in each grade level of 2, 5, 8, and 11 was made to identify classrooms with a particular teaching structure. This initial sample was randomly picked, and involved a group of 1084 students evenly distributed across these grades.

Based on scores of an instrument developed to measure these classroom structures, two distinct classroom structures at each grade level, composing a total of 408 students, were identified to study further. Students in these classrooms were given a measure of Individual Versus Group Attitudes Towards Science.

Approximately 10 students, randomly picked from each of the 16 classrooms were selected to be interviewed and to be given an open-ended sentence completion test to assess attitude. These subjects were equally represented in not only grade level, but also gender. Students were interviewed for about 45 minutes, and the interviews were taped and transcribe for further analysis.

Measures

Classroom Structure Measure

Previous research has suggested that classroom structure is a powerful correlate in predicting student attitudes, which in turn may predict student aspirations to pursue science for a career. The first phase of this investigation involved identifying four major classroom variables in each grade level: cooperative, competitive, student-centered (students are involved in initiating learning topics), or teacher-centered (teacher determines the learning topics). We hypothesized that students in cooperative and student-centered classrooms would have more of a tendency to state that they had more positive attitudes toward science and more science career aspirations than students in competitive and teacher-centered classrooms.

A search of current and available instruments (Individualized Classroom Environment Questionnaire - ILEQ, Learning Environment Inventory - LEI, My Class Inventory - MCI, Classroom Environment Scale - CES (Fraser, B. and Fisher, D., 1983)), revealed that none were exclusively designed for the identification of the specific classroom structures mentioned. Therefore, an instrument had to be developed which was

capable of measuring the variables of the classroom structures which we selected for this study.

These instruments were searched for desired constructs of classroom structure. A total of 123 appropriate constructs were extracted from the instruments and randomly ordered and printed on a questionnaire. Forty college of education students volunteered to categorize each statement in two ways, as either cooperative or competitive, and student-centered or teacher-centered. Using the degree of agreement among this group and the research team for a validity check, the classroom structure instrument was reduced to twenty-five items. Fifteen additional items were written by this team that were highly characteristic of the classroom structures we were seeking to identify, yielding a forty item instrument consisting of ten items describing each of the four classroom structures. (appendix A)

This instrument was administered in all 40 randomly selected classrooms with 10 classrooms in each of grades 2, 5, 8, 11 (n=1084). The respondents were asked to either agree or disagree that each statement was descriptive of their classroom. The items on the instrument were read to students in grades 2 and 5. Students in grades 8 and 11 read and responded to the items by themselves.

Measures of Attitude

Individual and Group Attitudes Toward Science

The purpose of this newly developed science attitude measure was to access how different classroom structures would affect individual and group attitudes toward science. This instrument was administered to all students in the sixteen classrooms, four in each grade level, which had been chosen for further study.

The instrument consisted of 30 questions designed to tap "groupness", or how the student perceived his/her own attitudes and abilities in science in comparison to other students or the class overall. Twelve questions pertained to the students' own perceptions of the science classroom (i.e. *"I think science is fun."*): another 9 questions assessed the students' perceived class attitude toward science (i.e. *"We, the students, feel that science is worthwhile."*); and 9 questions that assessed how the individual student saw other students' attitudes about science (i.e. *"Other students like science more than I do."*) Students responded to each question by placing an X along a 10-centimeter unscaled line to show the degree to which they agreed or disagreed with the statement. (appendix B)

Sentence Completion Instrument

This twenty item projective technique instrument was administered only to the 10 randomly selected students in each of the 16 classrooms who participated in the interview. It was developed primarily to qualitatively probe attitudes of students towards science , but it also served as an ice-breaker prior to the interviews and as a reliability check on the paper pencil attitude survey and interviews. Students were asked to analyze their own thinking and opinions as well as project themselves into the minds of their friends with such statements as *"My friends think science...."*; and *"If I were a scientist, my mother/father would...."*. (appendix C) The statements were read to the younger subjects (2nd and 5th graders) and the researchers recorded their responses verbatim. The older subjects (8th and 11th graders) completed the items independently.

Interviews

Interviews were conducted by the six members of the research team. Students, 10 each from 16 different classrooms, were randomly assigned to the interviewers.

Students were interviewed individually and away from their classroom. Interviews were tape recorded and later transcribed. Each interview took approximately 45 minutes.

All interviewers followed a protocol which specified particular types of probes and their order, but also encouraged individual digressions to follow up interesting issues. Questions were open-ended, often projective in nature. Interviewers began by asking students to describe their science class, and how they felt about it. Subjects were then asked projective cross-sex questions, such as how they (girl/boy) would feel about being a scientist if they were of the opposite sex, how their friends would react to knowing the subject wanted to be a scientist, and what their parents (mother/father) would say about their desire to be a scientist. They were asked how they might teach science differently if they were the teacher to improve attitudes of boys and girls. (appendix D)

Analysis

Classroom Structure

Separate grade level factor analysis with varimax rotation and two and four factor solutions were conducted using the data gathered on the classroom structure instrument. Because the sample was too small for analysis by individual grade levels, and because the data from grades 2 and 5 and grades 8 and 11 were sufficiently similar, a single classroom analysis was done. Since the four-factor solution offered no substantial explanatory

strength beyond the two-factor solution, the two factor solution was used. The first factor contained items which seemed to reflect a classroom atmosphere in which students had somewhat of decision into development of curriculum and rules and somewhat suggesting a degree of a cooperative climate. The second factor contained items which seemed to reflect a classroom atmosphere in which the teacher had a great deal of control of curriculum and rules and suggested a degree of a competitive climate. The first factor was interpreted as a cooperative student-centered classroom, and the second factor was labeled a competitive teacher-centered classroom.

Two classrooms at each grade level were chosen which had high mean factor scores on factor one (cooperative student-centered) and low mean factor scores on factor two (competitive teacher-centered). And two classrooms at each grade level were chosen which had low mean factor scores on factor one and high mean factor scores on factor two.

Individual vs Group Attitude Toward Science

A factor analysis using varimax rotation was done to reveal four factors on this instrument. The first factor contained items reflecting students' perception of the groups' attitude, and the fourth factor contained items reflecting individual attitude toward science. The second factor contained items reflecting work, pressure, difficulty and extrinsic motivational factors, while the third factor contained items reflecting academic self concept and intrinsic motivation.

Sentence Completion Test and Interviews

Qualitative data was obtained from the sentence completion test and the interviews. Interviews were transcribed and both interviews and the Sentence Completion Test were analyzed for central themes across grade levels, gender and classroom structure.

Quantitative data was also obtained from the sentence completion test. Three members of the research team individually coded each response as negative (1), neutral (2), or positive (3). The scores were averaged. Inter-rated reliabilities were good. In only 4% of the cases did the raters disagree among themselves by more than one point. Chi-square analysis was then conducted for each question to see if there were significant differences in response frequency across sex, classroom structure and grade.

Results

Classroom Structure

It was an original assumption of this research team that students would perceive their classroom as either cooperative or competitive, and teacher-centered or student-centered, and that this perceived classroom structure would have an effect on student attitude toward science and the pursuit of science careers. This, however, did not happen, as described above in the analysis of data for classroom structure. There appeared to be only two clear factors, which we named cooperative student-centered and competitive teacher-centered. Therefore, classrooms were investigated for attitude and career aspiration differences using these categories.

An analysis of students' perceptions of classroom structure across grades and gender was performed. A graph of factor score one (appendix

E) indicated that, with the exception of the second grade, females saw their classroom as less cooperative student-centered than do males. It is also clear from this graph that as both male and female students increase in grade level, they perceive their classroom as being less cooperative student-centered.

A graph of factor two (see Appendix F) indicated that through the 8th grade, mean scores are neither strongly positive or strongly negative, indicating that students in these grades saw their classroom as not competitive teacher-centered. However, there was a weak tendency for females to see their class as slightly more competitive teacher-centered than males. In the 11th grade mean factor scores were strongly positive, indicating that students now saw their classes as strongly competitive teacher-centered, and the mean scores for males and females were the same.

Data gathered from the interviews confirmed that females saw their classrooms as slightly more competitive teacher-centered, and also that they tended to prefer competitive teacher-centered classrooms. However, all students in these competitive teacher-centered classrooms were more inclined to dislike their teacher (chi-square=5.8, DF=1, p=0.019) and thought that their teacher should be easier (chi-square = 6.0, DF=1, p=0.015). Analysis of interviews offered one explanation for the greater perception on the part of the girls to view a class as more competitive teacher-centered. Girls tended to remember more activities such as reading from books, vocabulary practice, written questions, discussions, whereas boys from the same classes tended to remember less of those activities and more hand-on, open-ended experiments. Girls who were in competitive teacher-centered classrooms were less likely to reject science as a career,

whereas boys were more likely to say that they would pursue a career in science.

Boys, except in the second grade, perceived their classrooms as more cooperative student-centered, tended to prefer cooperative student-centered classrooms, and remembered more student centered activities. Boys in cooperative student-centered classrooms were less likely to say they had poor teachers. Students in these classes made more negative remarks about the girls in their classes (chi-square=12.5, DF=1, p=0.000), while those in teacher centered classrooms were more likely to make positive comments (chi-square=3.9, D=1, p=0.047). However, the girls in these student centered classes wished their teachers were nicer (chi-square=9.5, DF=3, p=0.024), and could comment less about what they liked about science. There was also a greater tendency for both girls and boys in cooperative student-centered classes to feel more positive support from their fathers to pursue science as a career (chi-square= 4.7, DF=1, p=0.030), and both gave career aspirations as the reason for taking more science in the future.

Attitude

Since a decline in attitude is also correlated with a decline in student enrollment in science courses and subsequent decline in entering scientific attitudes of students, both group and individual attitudes were measured across grade levels to probe for patterns. A factor analysis revealed four factors on The Individual vs Group Attitude instrument. The first and fourth factor contained descriptors of student attitude. The first factor was called group attitude, and the fourth factor was called individual attitude. (appendix

G) Individual attitude toward science was positive and high in second grade, but decreased as the grade level increased. Group attitude toward science also started out positive and high, but also decreased as the grade level increased, with a slight upturn in the eleventh grade. There was a slight difference between how students viewed their own attitude and how they viewed that of the group until the eighth grade. In eighth grade, students' individual attitude toward science remained about the same as fifth grade. However, eighth graders perceived the group attitude as significantly lower than their own attitude. By the eleventh grade, just the opposite was evident. Eleventh grade students had experienced a sharp decline in individual attitude, and now saw the group as having a more positive attitude than their own.

Data from the sentence completion test revealed that students were evenly split on whether they thought their friends had a positive 44% or negative43% attitudes toward science. When asked what their friends thought of science, eighth graders gave the lowest frequency of positive responses. (chi-square=21.6, DF=4, p=0.000). They also attributed more positive attitudes to their fathers 45% and their mothers 33% than to themselves, with the eighth graders seeing their mothers' attitude as more neutral (chi-square-9.9, DF=3, p=0.20), and their father as less positive. (chi-square=9.9, DF=3, p=0.011).

It is not surprising that peers did not have an effect on career choice. About 50% of the students said that their friends would think a science career was a positive career choice, while 50% did not. Their comments about their peers' approval tended to resemble ideas such as "The smart kids would think it were great if were a scientist."

When asked how their parents would feel if they pursued a science career, most students thought their parents would support them. Mothers were thought to be generally more supportive, while fathers were somewhat more ambivalent. However, more girls than boys saw their fathers as more supportive in their pursuit of science careers.

Students in cooperative student-centered classrooms had somewhat of a more positive attitude towards science than those in competitive teacher-centered classrooms, with the difference becoming less in the eleventh grade. (appendix H)

Boys had a more positive attitude toward science than the girls, with the girls attitude declining most dramatically between the second and the fifth grades. (appendix I)

Factor two contained descriptors resembling how the students perceived pressure and work in regards to their science class. These could be considered as extrinsic motivation factors. Students in the fifth and most especially the eighth grade perceived this pressure and work involvement associated with science, whereas second and eleventh graders seemed relatively free of it. (appendix J)

Factor three contained descriptors which resembled the academic self-concept of the students, or how they perceived themselves as far as hard workers, future scientists and liking science. These could be considered as intrinsic factors of motivation. Factor three, when plotted on a graph with mean factor scores, appears to be almost a mirror image of factor two. Second and Eleventh graders seem to be high on intrinsic motivation, and fifth and eighth graders were low on this factor.

Analysis of items from the sentence completion and the interviews indicated that many students were relatively unknowledgeable about the range of science careers and the necessary preparation for them. 55% of the students responded that they needed more information from science for careers. Even when some students expressed career aspirations which required extensive preparation in the field of math or science, their narrow perceptions of scientists prevented them from labeling them as scientists. Scientific careers were narrowly defined as working in a lab doing research. Respectively, 30-40% of the girls and boys across grade levels responded that they would like to pursue science careers. Some grade level differences emerged. Eighth graders were less likely to feel that they needed to study science to pursue a career. (chi square=10.1 DF=3 p=0.018)As the grade level increased, the interest in pursing a science career and the student's disposition toward science decreased. However, the data from the sentence completion test does not support the notion that liking science means that the student will pursue a career in science. Many students responded in interviews that they liked science, but that their career aspirations were elsewhere, especially with what they perceived as higher salaried professions.

gender differences

The analysis suggests that only a few gender differences emerged. Many of the traditional stereotypes, such as boys preferring the physical sciences, and girls preferring the biological sciences, did not emerge. The stereotypes may still be prevalent, for females, as evidenced in some interviews in which boys expressed notions such as the girls don't like to dissect animals. But when interviewing the girls, no such dislikes emerged.

More boys stated intentions to continue to enroll in science coursed,

even though they were not planning scientific careers, because they saw science as more practical than did the girls. Girls tended to correlate continued enrollment in science courses with the decision to pursue a science career.

In the interviews, girls and boys generally thought each other to be equally able in science. Girls tended not to respond to what they liked least about the boys in science class because "they were the same". However, boys, when asked what they least liked about girls in science class most likely responded more frequently with ambivalent statements such as "I don't know." and "I'm not sure."

role models

Data emerged from the interviews suggesting that early role models were important in materializing students' aspirations to seek a career in science. Students who expressed interest in science careers could name a specific adult role model who sparked an interest in science for them. They made comments such as "My Grandfather would take me out to the field to look at constellations.", and "My Dad is a doctor.".

Significance

This data supports research which documents a decline in student attitude across the grades. There was evidence from this data that individual students' attitudes towards science are high as they enter school, but decrease quite quickly through elementary and high school, with somewhat of a plateau in the eighth grade. This could be a reflection of the science-textbook mode of teaching that seems to prevalent in grades 3 through six, even in cooperative student-centered classrooms. At the middle school level, science lab courses could account for a leveling of the

decrease, but it is apparent that by the time students reach eleventh grade, individual attitude has taken another plunge. Students across the grades perceive other students' attitudes as better than their own, except for eighth grade. This low perception of others' academic attitude is not surprising in the eighth grade, where students tend to more readily vocalized displeasure with home and school in an apparent attempt to establish their own independence and identity. This low group attitude in the eighth grade was also paired with a greater feelings of pressure and work and lower self-motivation. It appears that middle grade students perceive much greater work loads and pressure than do students in primary grades or high school, and this most likely deserves further examination. Do middle grade youngsters spend more time in school, deal with more teachers, more homework, more after school responsibilities than other age students? And if so, do these extra pressures affect their intrinsic motivation to succeed? Or their perception of the groups' attitude toward science?

Girls' attitude is somewhat lower than boys' toward science through all grades, but there was no evidence from this data that girls and boys differed in their preference of activities in science (eg. zoology vs botany), or that they differed in their confidence to do science. In fact, there was a strong equalitarian theme throughout the interviews in regards to the girls' and boys' aptitude in science, and their equal rights to be scientists. However, continued probing with some high school students concerning the feasibility of raising a family and working as a scientist raised some concern over parenting responsibilities.

Role models continued to play a significant factor in female science career aspirations. A number of girls who expressed interest in future science careers reported significant persons (male or female) in their lives

who assisted them to become aware that they possessed the attributes and abilities necessary for careers in science. Boys who expressed interest in science careers did not necessarily report significant persons in their lives who had influence their career aspirations. Possibly because boys traditionally have more access to these careers, and also because cultural stereotypes more typically project males as scientists, boys may not need it pointed out that they possess attributes which would make them potentially good scientists. Many students across the grades stated that they knew of male scientists from their television viewing, textbooks, and real life, but had difficulty recalling female scientists. This data suggests that if teachers, extra-curricular organizations, and families provided many and varied opportunities for females to become familiar with female scientists to expand their concept of female participation in the science fields, they may find it equally easy as the boys to plan future science career aspirations, without the significant person in their life having to expand their attributes and abilities which would make them suited to science careers. This is not to imply that role models who inspire young students to take an interest in science are not of equal importance.

It appears that classroom structure has emerged from this research as a powerful correlate of attitude towards science, and deserves further examination. Individual student attitudes, both male and female, decreased as students perceived their classrooms to be less cooperative student-centered and more competitive teacher-centered. However, females overall preferred competitive teacher-centered classrooms and were more likely to reject science as a future career in competitive student-centered classrooms. Males preferred cooperative student-centered classrooms. Both genders were less likely to comment positively about the girls in

cooperative student-centered classrooms. Girls remembered more writing, males remembered more activities. This suggests that cooperative student-centered classrooms generate better student attitudes, but that the implementation of cooperative learning situations does not necessarily lead to a more equitable and effective learning environment for females. In fact, the data suggests that educators need to attend to the gender-interactions within groups. Females, having lower status, may be doing more of the writing activities, while males, having a higher status, may be doing more of the actual investigations, dominating conversations, asking for and receiving more help. These results are consistent with some research suggesting that within cooperative settings, gender may operate as a status characteristic (Berger, Cohen, & Zelditch, 1972: Berger, Connor & Fisek, 1974). Therefore, males might hold positions of power and prestige within groups (M. Lockhead & Hall 1976; M. Lockhead & Haris, 1984) and exhibit their social dominance by being selective in choosing to whom they talk. The question of status differences within groups may partially account for the preference of females for teacher-centered classes and needs further consideration. Implications for science teachers who are concerned with equity issues might be to vary teaching strategies (teacher-directed lessons, student-centered cooperative activities). When using cooperative student groups, teachers might attend to the possibility of status differences within groups and possible strategies to lessen those differences such as role responsibilities or assigning competencies to lesser status students, such as the females.

One of the most serious implications from this data is the fact that so many students are relatively unclear about career options in science. Many students, especially eighth graders, were unaware of even a narrow range

of scientific career options, or that these choices required preparation in science and math in high school and college. This is especially significant since this data was gathered in middle and upper-middle class communities where students may have more exposure to a variety of adult professionals, their conversation and literature. One would fear for the results of such a study done in a low socio-economic level. This data suggests that early and additional career information be introduced into the science or school curriculum. Intermediate grades may be an opportune time to begin science career development, especially since this research results found such a steady decline in group attitudes toward science until the eighth grade, where it plateaued. Most school systems begin career development during those middle school years, which may account for the group attitude swinging back up in high school. Early career development may be especially critical for females, who frequently correlated taking future math and science courses only with a decision to pursue a career in science.

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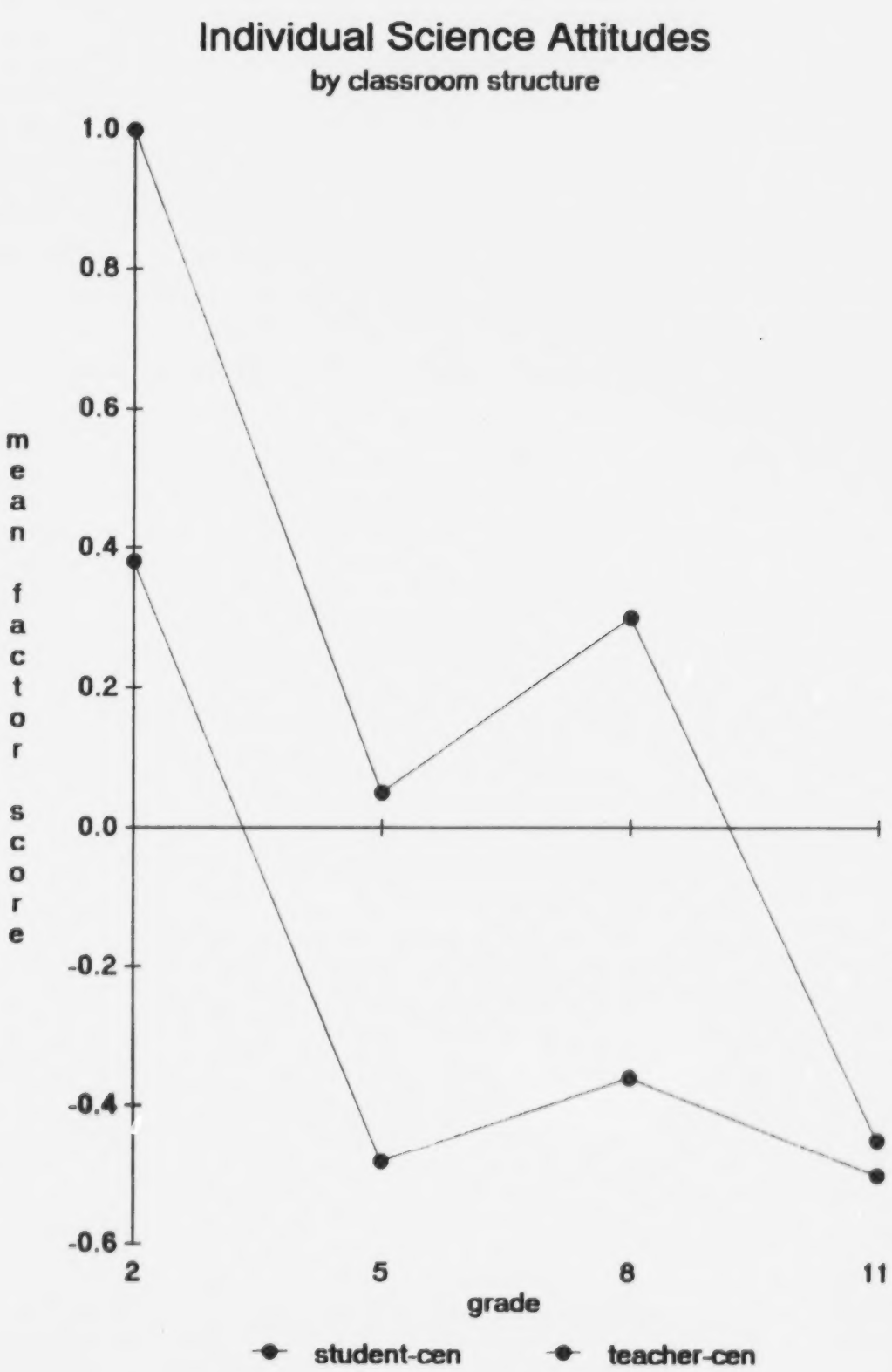
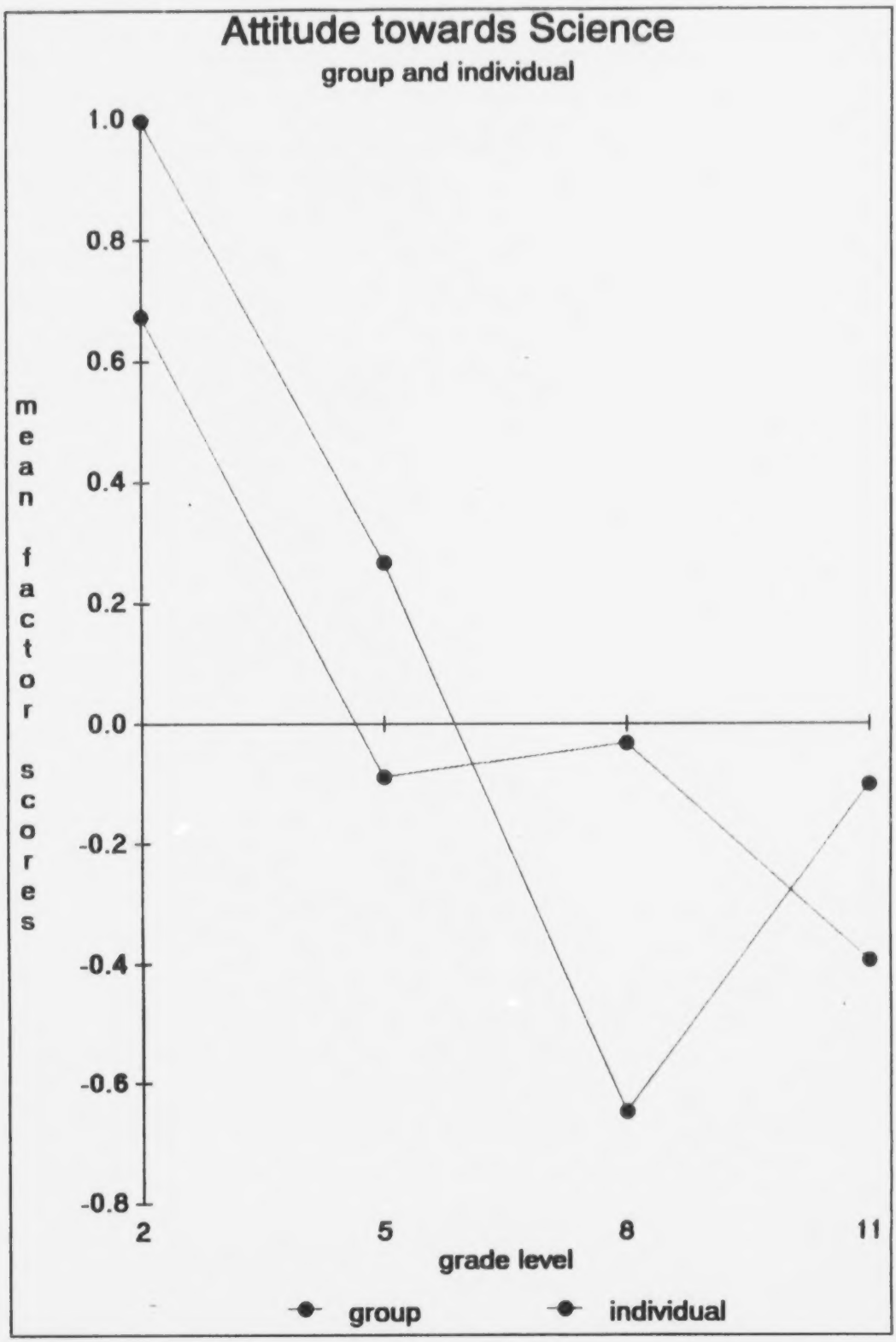
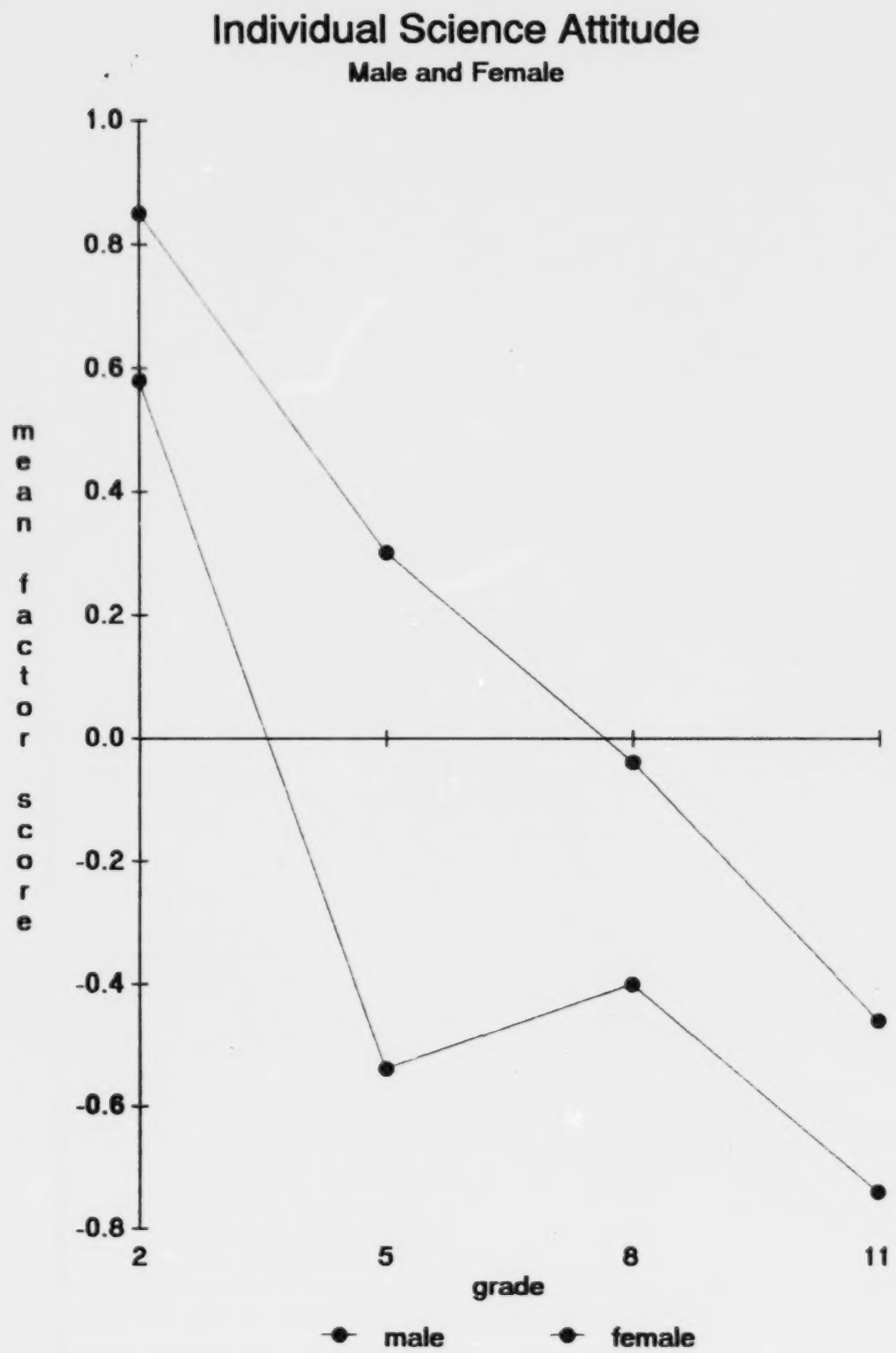
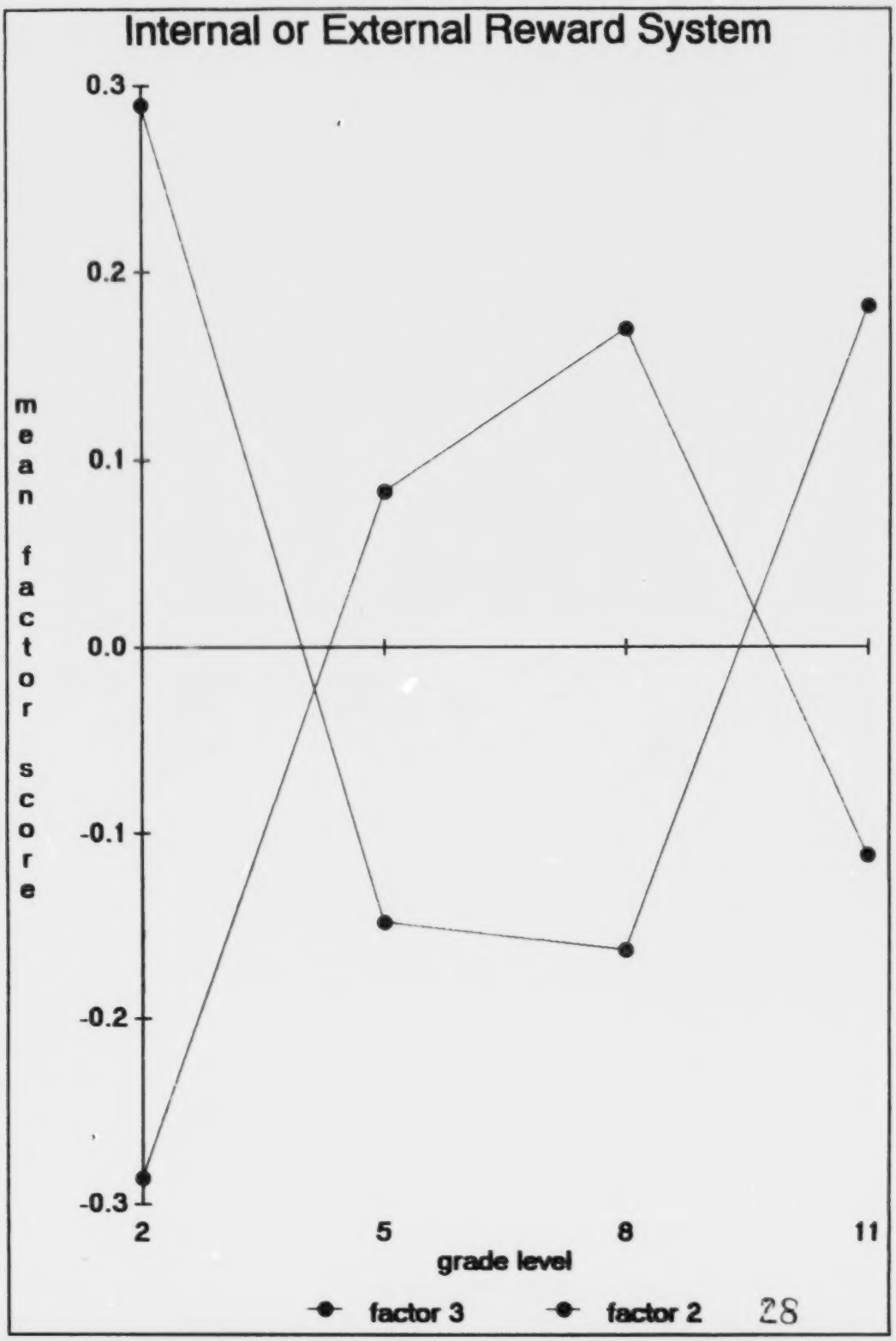

Individual Science Attitudes
by classroom structure
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
mean factor score
2
5
8
11
grade
student-cen
teacher-cen


Attitude towards Science
group and individual
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
mean factor scores
2
5
8
11
grade level
group
individual


Individual Science Attitude
Male and Female
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
mean factor score
2
5
8
11
grade
male
female


Internal or External Reward System
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
mean factor score
2
5
8
11
grade level
factor 3
factor 2